IMPROVED

GORDON-WHITWELL-COWPER FIRE-BRICK STOVES

113 IN USE

JUNE, 1891

PHILADELPHIA ENGINEERING WORKS, LIMITED

BUILDERS

MIFFLIN AND MEADOW STREETS

PHILADELPHIA

EDW. STERN & CO. PRS, PHILA.

FIRE-BRICK HOT-BLAST STOVES.

THE first three-pass stove had the combustion chamber on the side, from which the gases flowed in a right line across the stove, entering the down pass on top, and from it entering the chimney pass at the bottom, and then through the chimney pass directly out of the chimney. This was the simplest possible construction, and left nothing to be wished for in the way of efficiency, except that the first stoves were made with fine checker work in the last pass, which by carelessness clogged, checking the draft, and thereby limiting the amount of gas that could be consumed.

The plan had, however, two structural defects. One was the introduction of the blast into the chamber under the chimney above the third pass checker work. A powerful blast blew out the clay in which the bricks were laid and weakened the division wall above the checker work between the second and third passes. The bricks forming the top course of the chimney pass checker work were also displaced in the same manner. By introducing the blast into the bottom of the chimney just below the chimney valve all these difficulties were overcome. The blast then descended directly on top of the checker work, and, not striking any of the walls, did not blow out the clay. This defect has been very common in fire-brick stoves, and would not have been particularly noticed in either the Whitwell or Cowper, but in any new type all the difficulties are well heralded.

The second structural weakness was the large top arch which spanned the entire stove from side to side, the span of the arch being practically the same as the diameter of the stove. It was found that this arch gave way under heavy duties. The span was too great, and changes of temperature from gas to blast had too much effect upon it. It did not give way entirely, but bricks fell out. These bricks were made to interlock, and therefore broke away without the arch tumbling in. No attempt was made to overcome this defect while the circular iron-top construction was adhered to, and it remained for the complete remodeling of the stove, as shown in *Fig. 1*, to overcome it, and to secure a substantial construction throughout.

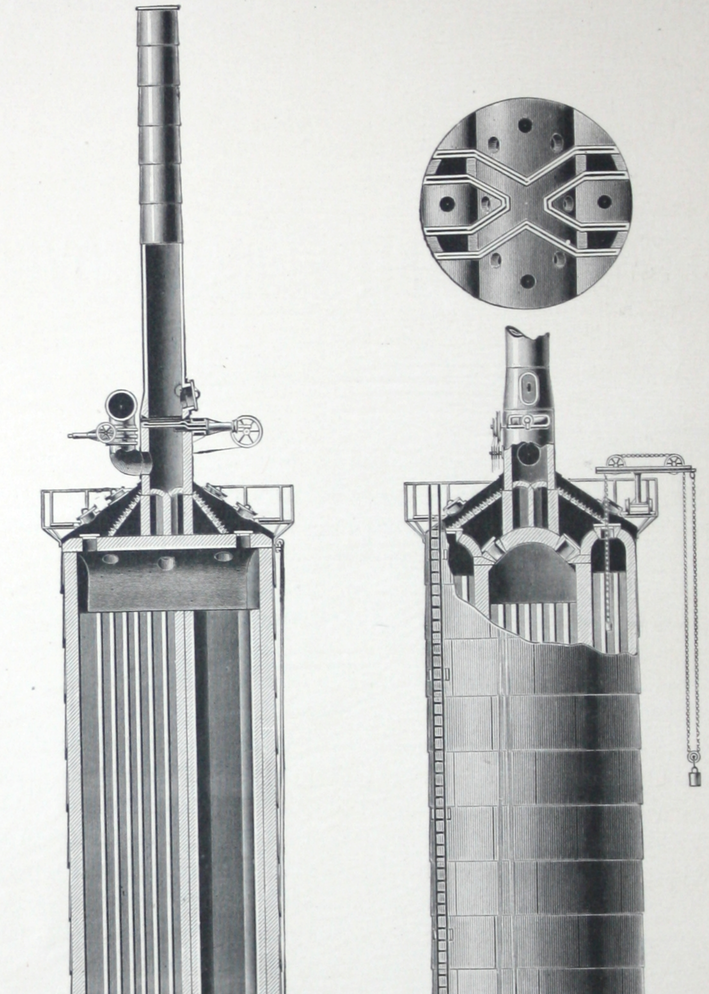

FIG. I.—HOT-BLAST STOVE.

The arch now spanning the combustion chamber and covering the first down pass has a span of just half the diameter of the stove, under which there is ample play for the gases, giving every opportunity for a utilization of all the checker work of the down pass. On top of this substantial short-span arch are built the flues to convey the gases from the top of the chimney pass to the chimney and the bottom brick work of the chimney proper. This work increases the stability of the arch and places between it and the iron shell sufficient material to prevent the latter from being injuriously heated at any time, no matter how strongly the stoves are worked.

This arch cannot provide an opening for the passage of the gases directly to the chimney. To reach the chimney the gases must pass down to the bottom and up the chimney pass. The gases from the combustion chamber enter the down pass, and having passed through it, enter through large arches into the chamber beneath the two symmetrical passes, forming a chimney pass, and rising through them give off their remaining heat to the checker work, and are received on top into chambers above the checker work. From each of these segmental passes there are two flues or passages, making four in all, leading to the base of the chimney. The side combustion chamber has been adhered to. It is theoretically true that if the highest heats be confined to the centre of the stove there will be less loss by radiation, but this loss is not appreciable, while the side combustion chamber can be cleaned more readily and a better diffusion of gas and larger heating surface obtained. The first stoves ever constructed by Mr. Cowper had the central combustion chamber, the gases descending all around it. This type was then abandoned and never revived until quite recently.

The checker work in all cases has 4½-inch walls and 9-inch openings, which are either square or circular. The circular flue is preferred by some, as it is thought that a round flue will not collect dirt as rapidly as a square one. This plan provides about the same amount of brick to the area of the pass, and gives about the same area for the passage of the gases or air. The cost of constructing the brick is about the same with either type, but it has not been demonstrated that the round has any particular advantages over the square opening. Experience has proven that a 9-inch opening is the most desirable throughout a stove. The stove keeps clean for a reasonable time without attention ; excessive friction is avoided, while a fair amount of heating surface is secured. Flues larger than 9-inch impair the heating surface while increasing the capacity to burn the gases. There may then be too much fuel burned for the amount of surface to absorb the heat in the time allotted and frequent changes will be required or an objectionable fall in the blast temperature experienced.

The system of cleaning by blowing steam directly with the current of the gases, from the bottom upward, has enabled the three-pass stove to be

efficiently employed for a period of three and one-half years without once stopping for cleaning or repairs, and then with only three-fourths of an hour's attention every week, and without stopping the stove for an instant. Besides, there is a top-cleaning device, consisting of weighted scrapers operated by chain wheels on a carriage tracking around the stoves, so the cleaning may be effected through any door with equal facility.

The efficiency of the draft must be measured at the bottom of the combustion chamber, where the gas and air enter, and when the stove is doing the full duty for which it is designed. To insert a manometer in the draft stack is to measure the power provided for the work without determining the power required. To measure the draft in the combustion chamber measures what power is left after all the work is done. It is a fact that ordinary detached chimney stoves of the two or four-pass type have a pressure of gas within the stove on top when they are doing their full duty, the chimney power being more than exhausted in pulling the gases down the down pass and through the valves and flues leading to the chimney. Their draft is due entirely to rarefaction of the gases in the combustion chamber, less this excess of pressure. Hence, the three-pass stove, with an outlet on top, gains by a simple hole more than all the power of draft which the two or four-pass stove can possibly have.

The draft has everything to do with the capacity of the stove, as its power is a measure of the quantity of fuel that can be consumed in the stove in a given time, and that is a measure of the quantity of heat provided.

One of the 20-foot three-pass stoves consumes the entire gas coming from a coke or anthracite furnace when making 100 tons of iron per day. Two will, therefore, heat the blast for a product of 150 tons of iron per day to a temperature of 1,400 to 1,500 degrees. In ordinary practice, about one-third of the gas coming from a furnace is used for heating the blast. The objection heretofore raised, that a stove could not be heated as rapidly as cooled, is removed. The objection to two fire-brick stoves, on the assumption that one may give way, and by its failure stop the furnace, is not well taken where economy of construction is a prime consideration. There is no part of a furnace plant less liable to give trouble than the modern three-pass fire-brick stove, and it can be cleaned while in use. The brick work is massive. The brick wall between the shell and the combustion chamber is 22½ inches thick. The shell never gets so hot that the hand cannot be placed upon it and held there. The cross division walls are made 13½ inches thick. The arches are 18½ inches, and the bottom brick work is formed of massive piers and walls, sufficient to withstand a height of 150 feet.

The valves have been revised, remodeled and improved after 15 years' experience. The chimney valve, *Fig. 2*, is just the same as it has been for the last five years. The efficiency with which its valve and seat are cooled by

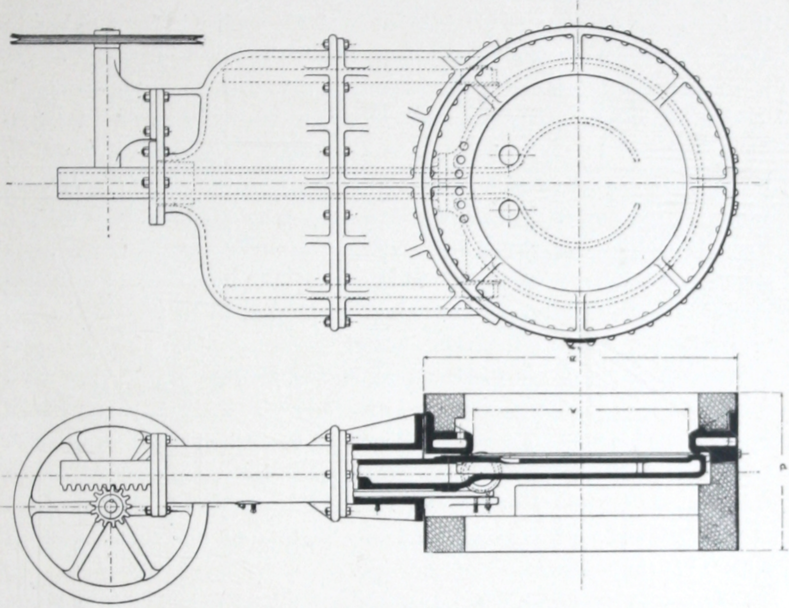

FIG. 2.—CHIMNEY VALVE.

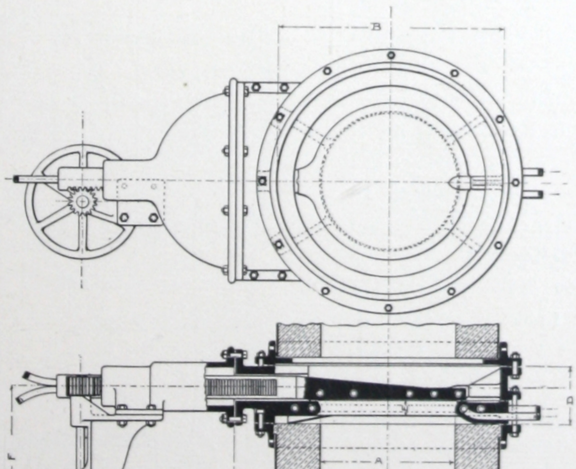

FIG. 3.—HOT-BLAST VALVES.

the incoming currents of air, induced by draft, renders it thoroughly durable. Its simple construction precludes liability to disarrangement, and as it is withdrawn entirely from the currents of the gases when it is opened, it neither impedes these currents nor is injured by them. This form is therefore employed in preference to the mushroom or poppet valve, which, though less expensive, so seriously interferes with the chimney currents, while it is exposed to the heat of the waste gases. The cold-blast valve is a simple slide device, seated by gravity. The hot-blast valve, *Fig. 3*, is a water-cooled valve, with a removable seat of cast-iron, coursed with lap-welded tubing. This is preferred to bronze castings, as by the stoppage of the water the bronze will crack, whereas the wrought-iron pipe, well protected with cast iron, will withstand the highest temperature of blast for a considerable length of time without being injured. The whole valve is of cast-iron, and is bolted between machined flanges, which are in turn riveted to the hot-blast pipe. Either the whole valve body, cap and all, can be removed, the cap and the valve removed, or the water-cooled seat removed at pleasure and very promptly, and any portion of these parts can be replaced by duplicates made to templates.

The air valve, *Fig. 4*, is a flat surface valve, held to its seat by a heavy wrought-iron bale. It is not affected by the heat, as it is so far removed from it, being entirely different from the original type of air valves introduced with these stoves. The gas valve, *Figs. 5 and 6*, is a heavy plate operated by double racks and pinions, introduced between two cast-iron flanges in the gas conduit. It serves as a cut-off or as a regulating valve. The valve, playing between the flanges, is always exposed to view, and can be kept clean without difficulty. Clamp screws either release or tighten this plate to fix it against the pressure of the blast. Its employment is essential, as it precludes the possibility of the gas entering the gas mains, which was so common with the older types of gas-inlet valves. Stoves of equal size cost practically the same, whether Cowper,

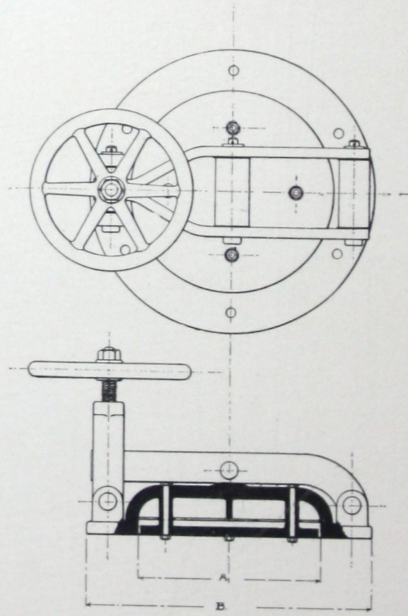

FIG. 4.—AIR VALVE.

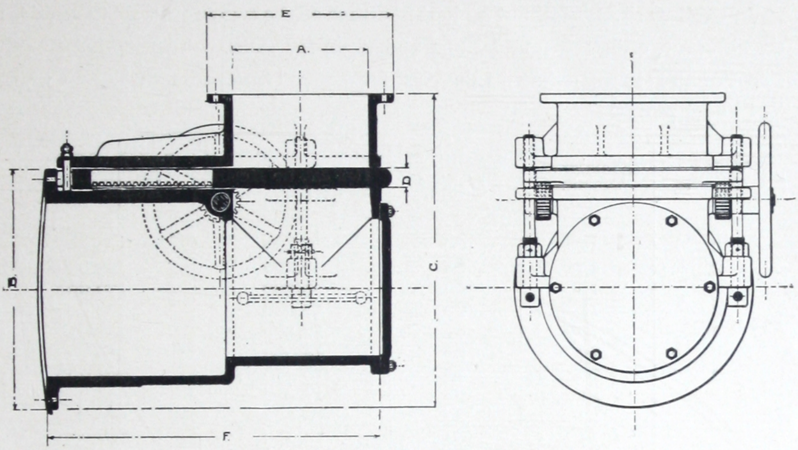

FIG. 5.—GAS VALVE FOR OVERHEAD GAS MAIN.

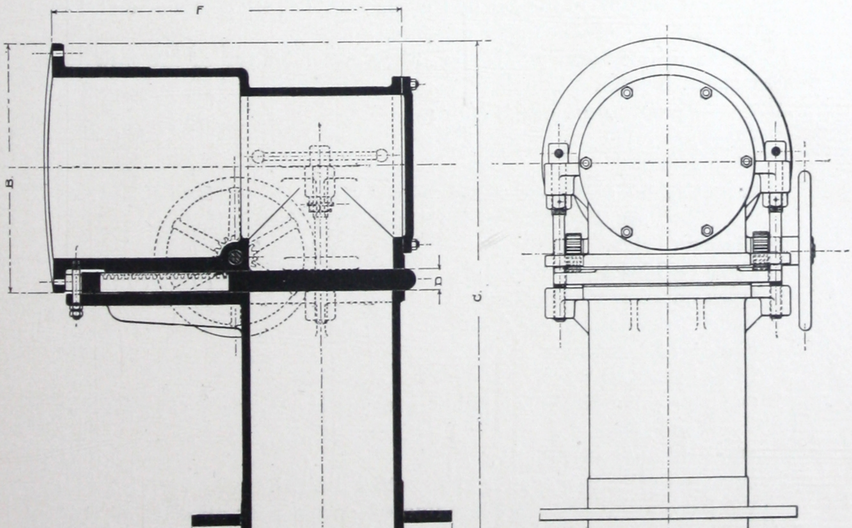

FIG. 6.—GAS VALVE FOR UNDERGROUND GAS FLUES.

Whitwell or three-pass, but a plant of either of the two former types requires a chimney, chimney foundations and chimney flues, which, added to the cost of the stoves, enhances the cost far beyond that of a three-pass plant of equal power.

Number of Stoves.	Diameter of Casing.	Height to Base of Chimney.	Cubic Feet of Blast that can be Heated to 1,500° F.	Pounds of Coke or Anthracite per 24 Hours.
2	14	60	6,600	123,000
2	15	60	8,200	155,000
2	16	60	9,300	176,000
2	17	60	11,000	209,000
2	18	60	12,500	237,000
2	19	60	14,000	266,000
2	20	60	16,000	304,000
2	21	60	18,000	342,000
2	22	60	20,000	380,000
3	14	60	10,000	190,000
3	15	60	12,000	228,000
3	16	60	14,000	266,000
3	17	60	16,500	314,000
3	18	60	18,500	351,000
3	19	60	21,000	399,000
3	20	60	24,000	456,000
3	21	60	27,000	513,000
3	22	60	30,000	570,000

MANAGEMENT OF FIRE-BRICK STOVES.

Control the flow of the gas by the gas valves at all points of exit, keeping the gas mains always under pressure.

Never open a bleeder valve or other outlet on top of the furnace or other elevated point.

To change a stove from gas to blast:

Close gas valve,

Close chimney valve,

Note that hot air comes out of the air valve. If so, close air valve. If not, see that chimney is fully closed; then—

Close air valve,

Open cold-blast valve slowly,

Open hot-blast valve quickly.

To change from blast to gas:

Close hot-blast valve,

Close cold-blast valve,

Open air valve within bale till air pressure is nearly gone; then throw it wide open,

Open chimney valve fully,

Open gas valve to mark for temperature desired.

We have a full and complete line of patterns for all sizes of stoves, valves and fittings, and shall be pleased to submit prices and specifications upon application.

PHILADELPHIA ENGINEERING WORKS, LIMITED,

PHILADELPHIA, PA.

JUNE, 1891.

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PHILADELPHIA, PA.

BLAST FURNACE PLANTS
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GAS ESCAPE VALVES
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CUT-OFF VALVES
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